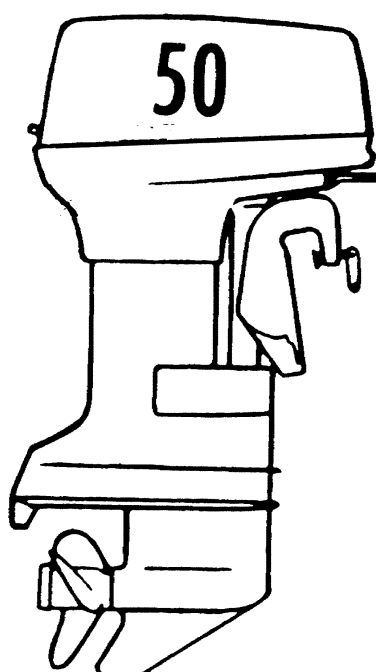


OUTBOARD MOTORS

FOR PACIFIC ISLAND MARINERS

**RESTRICTED CLASS 6-MASTER/ENGINEER
SPC O22C**



LEARNER'S GUIDE



SECRETARIAT OF THE PACIFIC COMMUNITY



GOVERNMENT OF TAIWAN/ROC

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1. Introduction

The Outboard Motors module of the Class 6 Master/Engineer certificate has been designed and is intended for the skippers of small boats (less than 15 meters in length), powered by outboard motors and operating in near coastal waters. The content of the module has been modeled on section 3 of the Engineering module (SPC 022) of the Class 6 Master/Engineer course developed by the Regional Maritime Programme of Secretariat of the Pacific Community. It has been modified to meet the requirements of small-boat skippers in Pacific Island countries and territories who primarily use outboard motors as the main form of boat propulsion.

This Learner's Guide is designed for students who are being trained and assessed on the Outboard Motors module (SPC 022C), as part of a Class 6 Master/Engineer course. Attendance at the module sessions and studying of the Learner's Guide should be sufficient for understanding the operation of a small outboard motor and being well skilled in trouble shooting and maintenance procedures.

2. Programme development

The resources materials were produced with financial support from the Government of Taiwan/ROC and compiled by Grant Carnie, Manager of Fishing & Maritime Programmes, Australian Fisheries Academy, Adelaide, South Australia.

The materials were developed through consultation with staff of the Fisheries Training Section, Coastal Fisheries Programme, Secretariat of the Pacific Community and regional experts on fishing and maritime training. Resources from Australia and New Zealand, SPC training materials and valuable resource material such as the *Australian Boating Manual* by Captain Dick Gandy were used as a guideline in developing materials that were relevant to small-boat operators in the Pacific Island region.



PART B COURSE INFORMATION

1. Module name

Outboard Motors SPC 022C.

2. Prerequisites

There are generally no prerequisites for completing the Outboard Motors module however, the prerequisites for the Class 6 Master/Engineer certificate (Full or Restricted) are a Safety Certificate and some sea time. Refer to local regulations for any specific country requirements.

3. Course duration

Two days (at the discretion of the course provider).

4. Assessment

Candidates doing the Outboard Motor module will be assessed as they are completing the competencies.

5. Recognition of Prior Learning (RPL)

If students have been assessed previously for some of the learning outcomes or believe that they are already competent in certain areas, they can apply to the trainer/assessor to have these particular skills recognised.

6. Resources

The resources required by anyone attending the Outboard module are minimal. An in-depth study of this Learner's Guide and attendance at all sessions of the training should be sufficient for a candidate to successfully complete the module. Candidates should check with the training institution offering the course with regard to clothing requirements for the practical components.

Anyone wanting additional resource materials could borrow or purchase a copy of *The Australian Boating Manual* by Captain Dick Gandy or *FAD Fishing Skills Workshops, SPC Module 2, "Safety at sea and Small Boat FAD Fishing"* or *Section 3 (Outboard Motors) of the Engineering module (SPC 022)* from SPC.



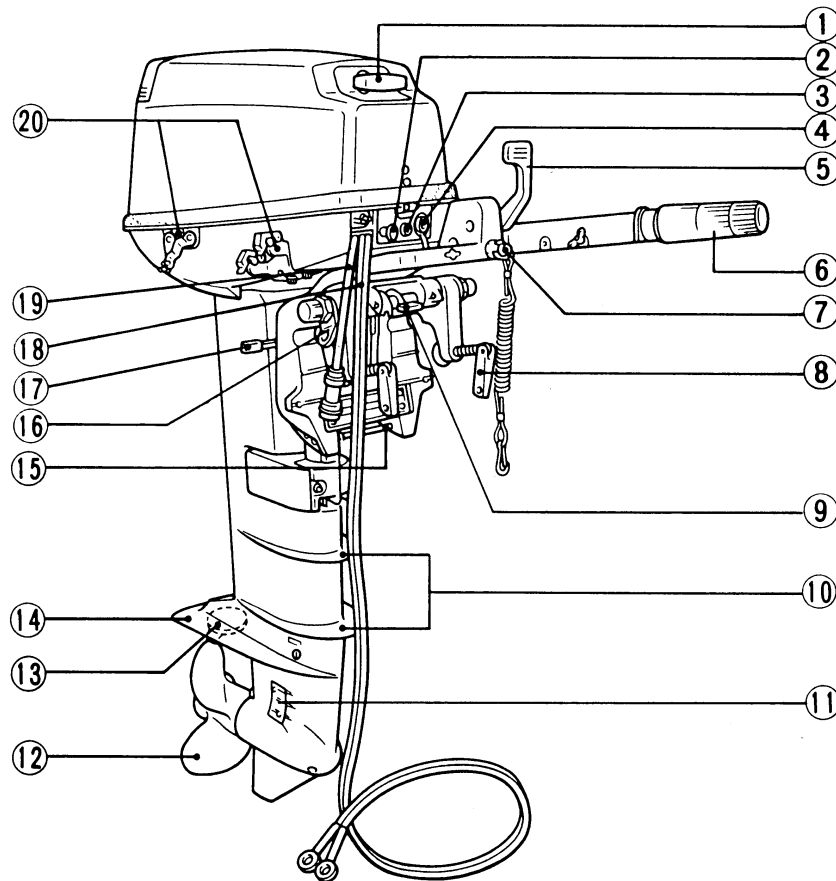
SECTION 1

OUTBOARD MOTOR OPERATION



THE OUTBOARD MOTOR

Most outboard motors are petrol-driven, two-stroke engines although four-stroke engines are becoming more common. Outboard motors may have from one to eight cylinders.



A 2-CYLINDER 25 HP YAMAHA OUTBOARD

- | | |
|---|---|
| 1. Manual start recoil handle | 11. Cooling water inlet |
| 2. Choke knob | 12. Propeller |
| 3. Overheat warning lamp | 13. Zinc anode used for steering adjustment |
| 4. Electric start button | 14. Anti-cavitation plate |
| 5. Gear-shift lever (usually absent on very small motors which are pivoted by 180° for reverse drive) | 15. Rod for adjusting trim angle |
| 6. Throttle control & steering handle | 16. Rope attachment |
| 7. Emergency-stop (kill) switch, lock plate and lanyard | 17. Shallow-water lever for raising motor |
| 8. Engine securing clamp | 18. Battery lead |
| 9. Tilt lock for preventing accidental tilting | 19. Wiring harness |
| 10. Anti-splash plates | 20. Remote control attachment |



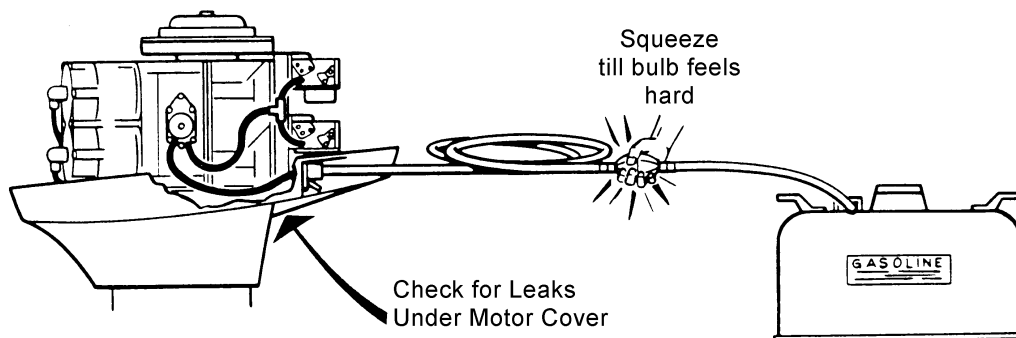
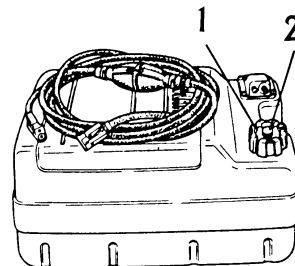
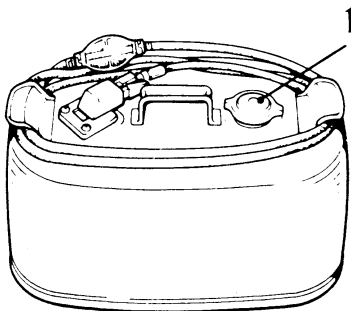
FUEL SYSTEM (portable)

Portable fuel tanks for outboard motors are fitted with a **manual priming bulb**. It is squeezed a few times to draw fuel when first starting the engine or to continue to provide fuel to the engine in case of fuel pump failure. Care must be taken to ensure that the bulb is not over squeezed as this may cause leaks in the fuel system or flood the engine with too much fuel, making it difficult to start. The bulb should be squeezed only until it becomes firm.

The tank is also fitted with a **breather screw**, which must be loosened to vent the tank when operating the engine. Ensure the breather screw is fully closed when transporting the tank to prevent spillage.

The fuel line connection to the tank should be self-locking, and the connection to the motor should be either the quick-release type or automatic shut-off type when the fuel line is disconnected.

Portable fuel tanks should not be left partially empty for long periods as the fuel can become contaminated with moisture buildup and algae growth. They should be filled ashore to avoid spillage on board and secured on board to prevent movement.

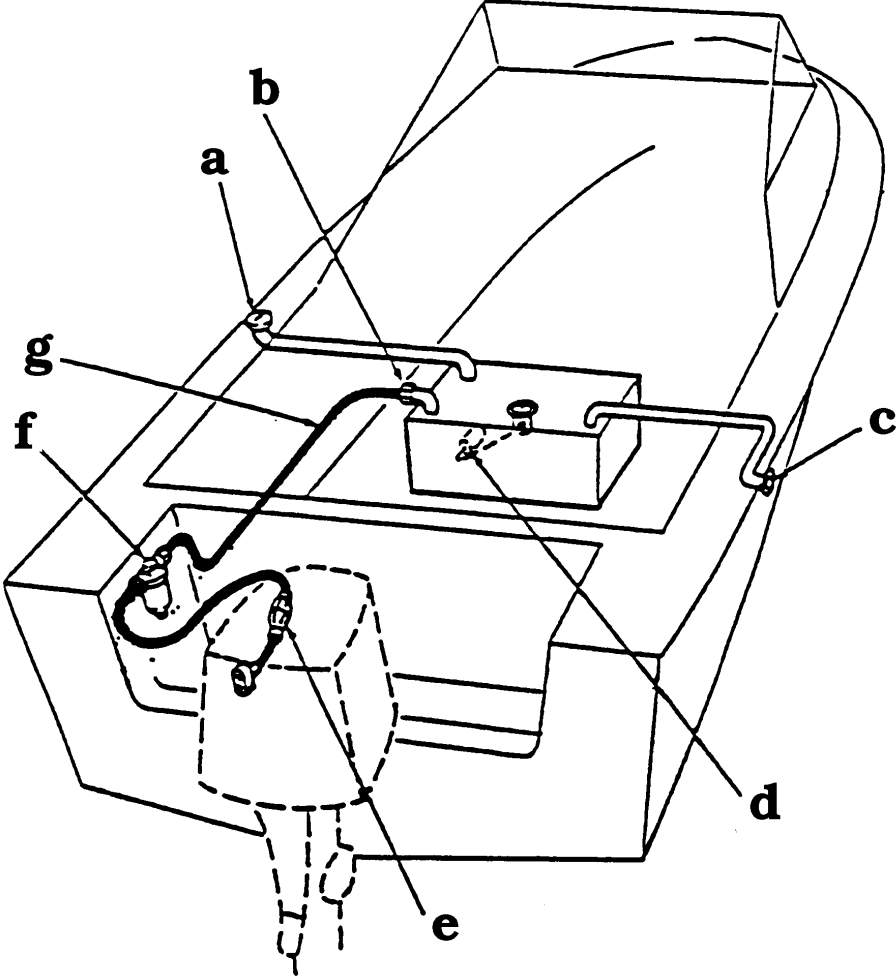


PORTABLE FUEL SYSTEM

1. Filler cap
2. Breather screw



FUEL SYSTEM (fixed)



FIXED FUEL TANK

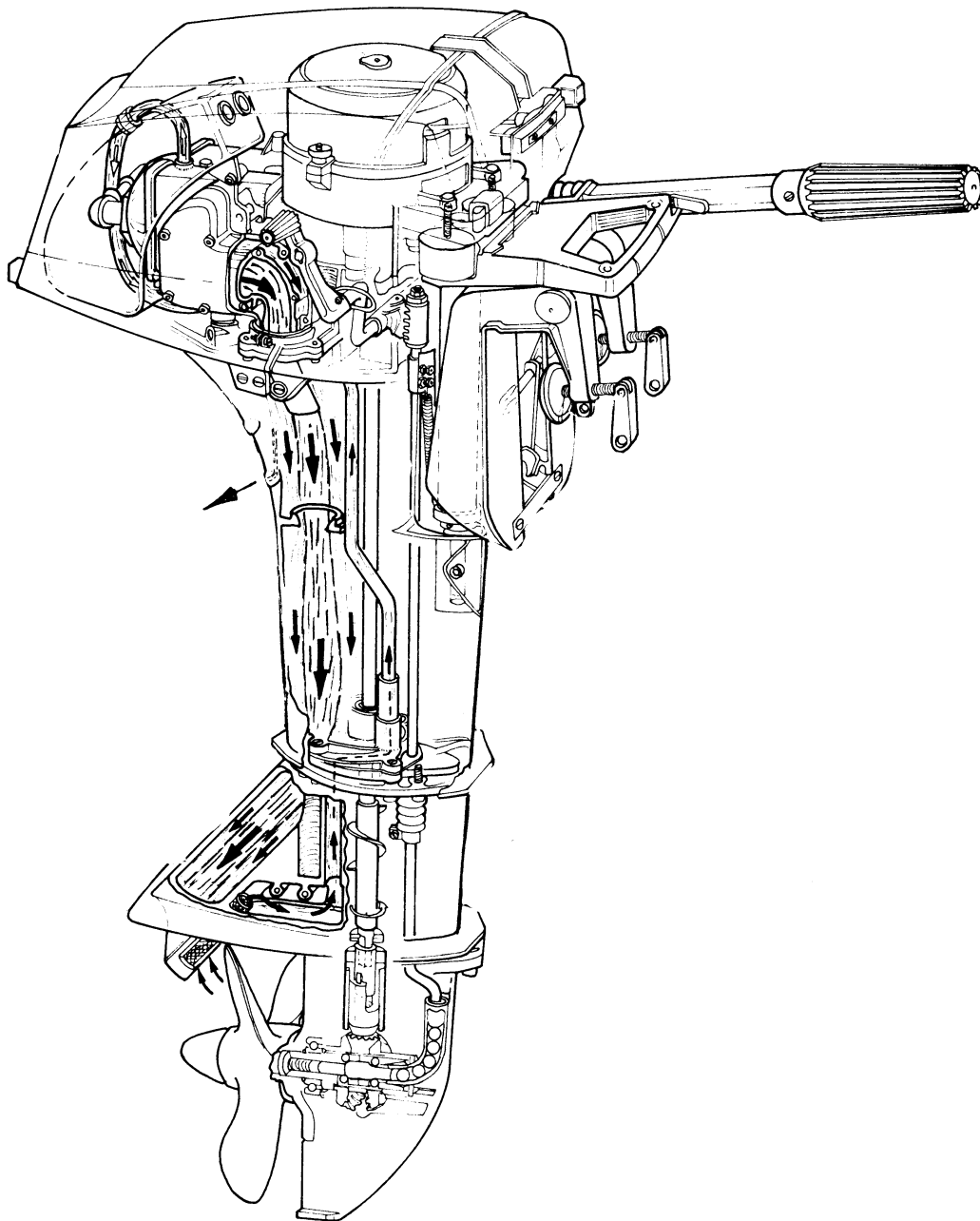
- a Fuel filling point/cap
- b Anti-siphon fitting
- c Fuel tank breather
- d Fuel level indicator (float)
- e Manual priming bulb
- f External fuel filter
- g Flexible fuel line



COOLING SYSTEM

The outboard cooling system is the direct, raw water type. Sea water is drawn up by an impeller pump, made of plastic or rubber, which is located in the lower leg. It then passes through the galleries in the engine and out through the exhaust.

A small stream of water is also bled off somewhere in the system as a tell tale sign, indicating to the operator that water is circulating throughout the cooling system. A thermostat maintains a minimum operating temperature. An audio alarm and a "hot light" are also sometimes fitted.



THE OUTBOARD MOTOR COOLING SYSTEM



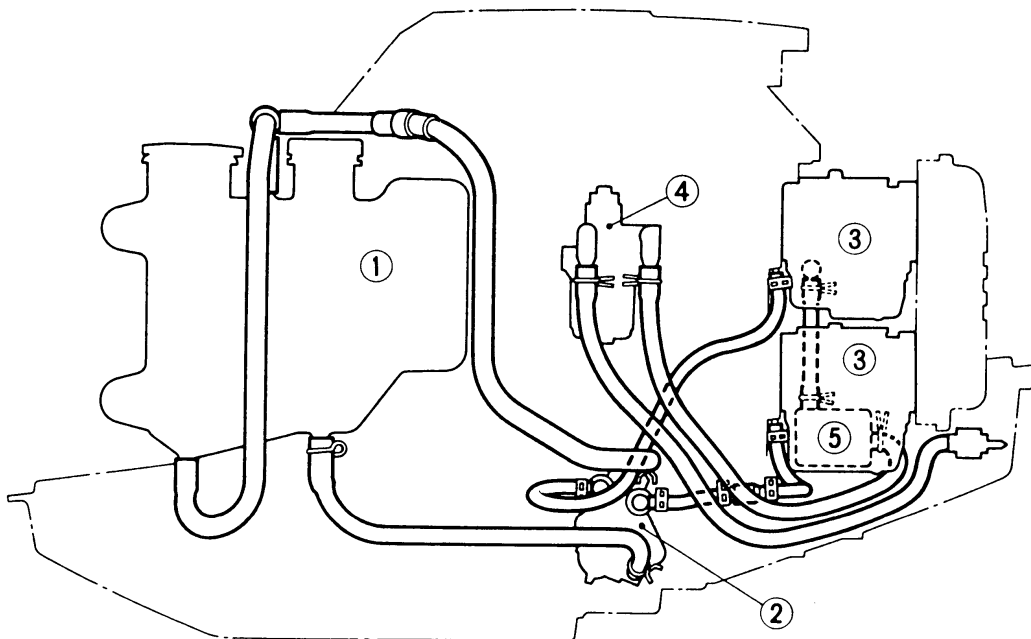
INTERNAL LUBRICATION SYSTEM

Two-stroke engines need their crankcase for compression, therefore, a circulating oil system is not possible. Their lubrication is achieved by mixing oil with petrol in one of two systems. Oil is either poured into the fuel tank and mixed by shaking or mixed as required by an oil injection pump known as the “Variable Ratio Oiling” (VRO). Modern two-stroke engines are usually fitted with such precision blend systems. Diesel and four-stroke petrol engines are lubricated by oil circulation from the sump (crankcase).

Insufficient oil will cause the engine to overheat and eventually seize. Excessive oil will foul the spark plugs, cause smoky exhaust and heavy carbon deposits. Both will cause engine failure.

The required amount of oil per litre of petrol varies between 1:100 and 2:100. The manufacturer’s recommendations should be followed. Paint the correct oil/petrol ratio on the fuel tank and use only the recommended two-stroke outboard motor oil.

With oil injection systems, the VRO pump automatically adjusts and mixes the amount of oil required by the engine under different conditions and speeds. It may even be fitted with a no-oil alarm to warn the operator when the engine is receiving no oil. If the reservoir of the VRO pump runs dry during engine operation, the operator should stop the engine and refill it.



YAMAHA PRECISION BLEND LUBRICATION SYSTEM (VRO)

- | | |
|-----------------------|----------------|
| 1. Lube oil tank | 4. Fuel filter |
| 2. Oil injection pump | 5. Fuel pump |
| 3. Carburetors | |



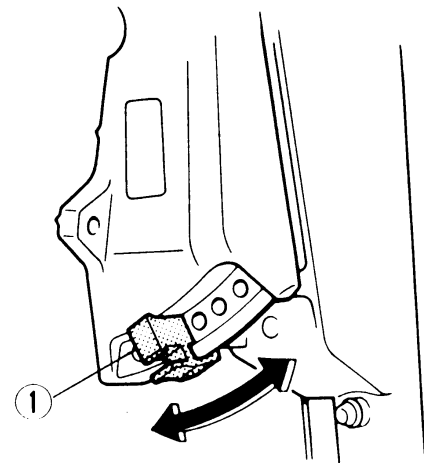
MOUNTING AN OUTBOARD MOTOR

There are two methods of securing an outboard motor to the stern of a vessel. One involves the use of hand-tightened screw thread clamps. These clamp the transom of the vessel between the engine mounting bracket and the screw thread plates. Their tightness should be checked each time the engine is used. A safety rope or chain should also be used to secure the motor to the vessel and prevent the motor from dropping from the stern if the clamps get loose during vessel operation. On larger outboard motors, the mounting bracket is usually bolted through the transom plate. This is a more secure method, but regular checks must be made for looseness.

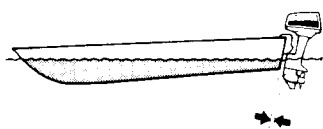
Trim Angle

By changing the outboard motor's drive angle, the vessel's bow can be made to rise or fall. The performance and stability of a vessel depends a great deal on correctly trimming the outboard. The correct trim angle depends on the vessel's handling characteristics, the size of the outboard, the sea and loading conditions. Care must therefore be taken to ensure the outboard is trimmed correctly under different sea and loading conditions.

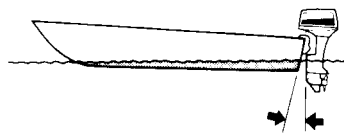
On smaller outboards, the trim angle is adjusted manually by moving an adjusting rod to different holes in the mounting bracket. The bigger outboards usually have a Trim Switch fitted on the remote control lever.



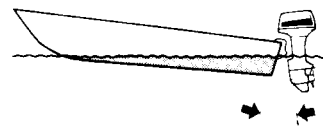
**YAMAHA'S TRIM ANGLE
ADJUSTING ROD**



INSUFFICIENT ANGLE
(Bow digs)



CORRECT ANGLE
(Top performance)

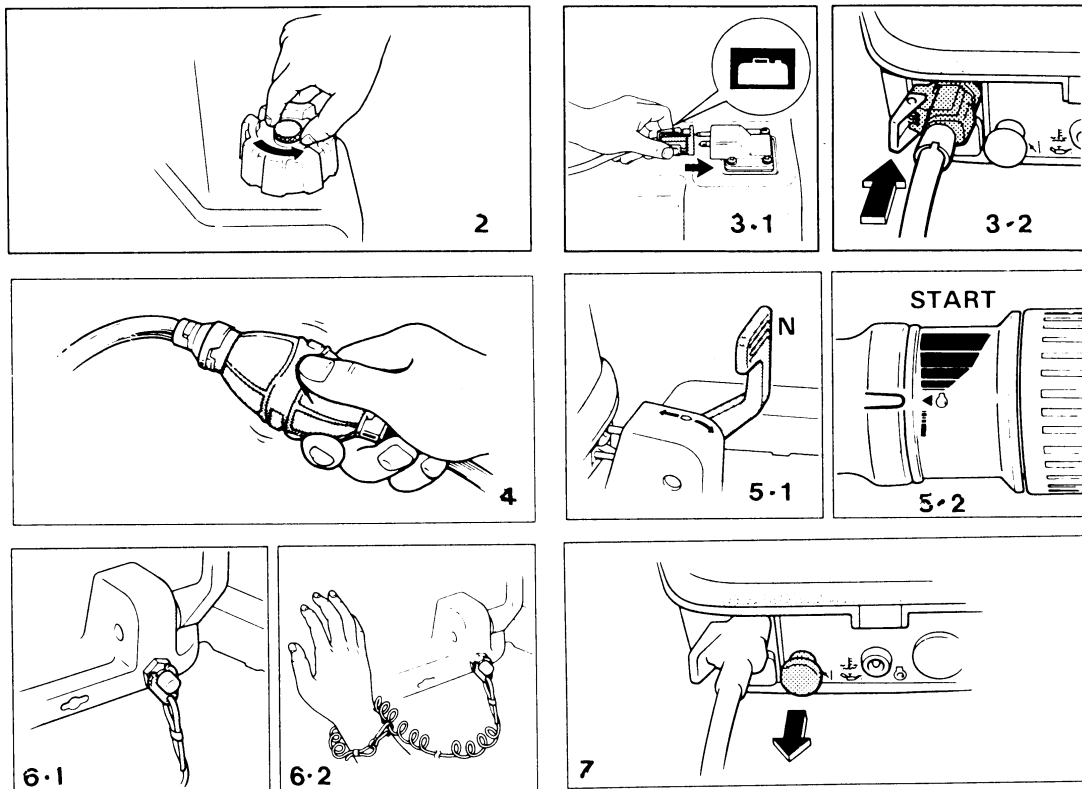


EXCESSIVE ANGLE
(Transom drags)



STARTING PROCEDURE

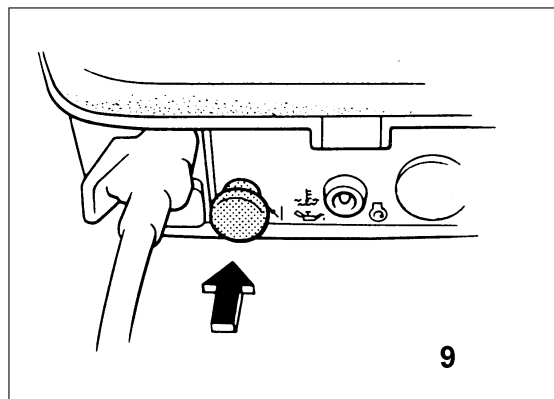
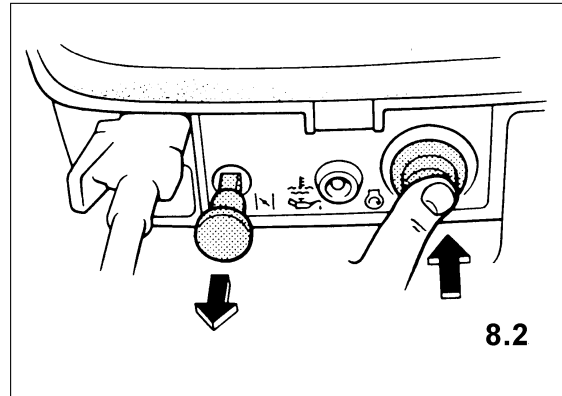
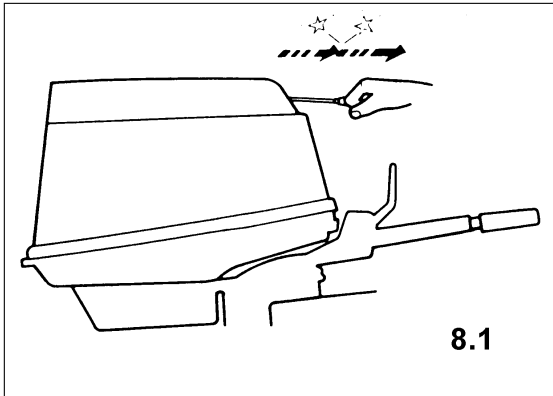
1. Lower engine to running position and check the following
 - Fuel level
 - Oil level (if separate lube oil tank)
 - Engine mount secure
 - Propeller clear
2. Loosen air-vent screw on fuel tank cap by 2 or 3 turns (if fitted)
3. Firmly connect fuel hose to both fuel tank and engine
4. Squeeze primer bulb until it becomes firm
5. Make sure engine is in neutral, and throttle grip on handle in START position
6. Clip lock plate onto emergency-stop switch and tie lanyard to your wrist
7. Pull out choke if starting cold engine



STARTING A YAMAHA OUTBOARD



8. Start motor by pulling starter handle (manual) or pushing starter switch (electric)
9. Push choke back in
10. Check for "tell tale" water stream and allow engine to warm up before moving off



STARTING A YAMAHA OUTBOARD (CONTINUED)



SECTION 2

TROUBLESHOOTING



ENGINE FAILS TO START

1. Check level of fuel in tank
2. Check air vent screw on tank open
3. Check arrow on primer bulb to ensure fuel line is connected the right way
4. Check fuel lines connected tightly and bulb primed
5. Check engine is in neutral and throttle control in START position
6. Inspect battery and connections (electric start)
7. Check emergency-stop (kill) lock plate connected correctly to switch
8. Inspect fuel filters (fuel tank, external, internal) and clean if necessary
9. Check internal fuel filter to ensure filter casing is tightly screwed
10. Inspect spark plugs and clean if necessary
11. Check fuel pump to ensure membrane is not torn out
12. Check carburetor to ensure that draining screw is not opened

If engine starts but stops almost immediately:

1. Check choke has been pushed back in
2. Checks 1 to 12 above

If engine starts but stops when gear is engaged:

1. Check propeller is not blocked
2. Inspect spark plugs and clean if necessary

If engine still fails to start seek mechanical advice

ENGINE OVERHEATS

1. Check water pump and thermostat operating correctly by checking if "tell tale" water stream is at normal rate
2. Inspect/clear water intakes (plastic bags?)
3. Check oil level if separate lube oil tank is fitted

If problem cannot be rectified seek mechanical advice

ELECTRICAL FAULT

1. Check for loose or dirty battery connections
2. Check electrolyte in battery at correct level
3. Check level of charge of battery with hydrometer
4. Check "kill" switch is connected correctly
5. Inspect spark plugs and connections and clean or replace if necessary

If problem cannot be rectified seek mechanical advice



ENGINE HAS BEEN SUBMERGED

If outboard motor mounts are not checked regularly, the engine can shake loose and fall overboard. The safety rope or chain should be short enough to prevent the engine going underwater. If these measures are not followed, you will have to deal with an outboard motor which has been fully submerged.

Once an outboard has been immersed in sea water, it must be serviced **immediately** as electrical components and internal parts will begin to corrode. If the engine cannot be serviced immediately, it should be re-submerged in fresh water to prevent corrosion until it can be serviced.

Servicing after submersion

1. Remove engine cover and rinse powerhead with fresh water
2. Disconnect spark plug leads and remove spark plugs
3. Disconnect fuel lines from engine. Drain and clean all fuel lines and fuel tank
4. Place engine in horizontal position (spark plug openings down) and work all water out by slowly rotating flywheel about 20 times or until there is no sign of water
5. Drain carburetor: place engine in upright position and remove carburettor for disassembly and draining
6. Disassemble, clean and flush the starter, electrical connectors and all electrical equipment with fresh water. Then treat them with a water displacing electrical spray and thoroughly dry them before assembly
7. Inject outboard lubricant into spark plug holes
8. If engine shows evidence that sand may have entered it (sand under the engine cover or a slight grinding or scraping when the flywheel is rotated) do not attempt to start the engine. It must be disassembled and cleaned.
9. Reassemble the parts. Start the engine and run for 30 minutes in fresh water.
10. If engine fails to start, remove spark plugs again and see if water is present on electrodes, if so, blow out water and reinstall or replace with new plugs. Repeat starting procedure



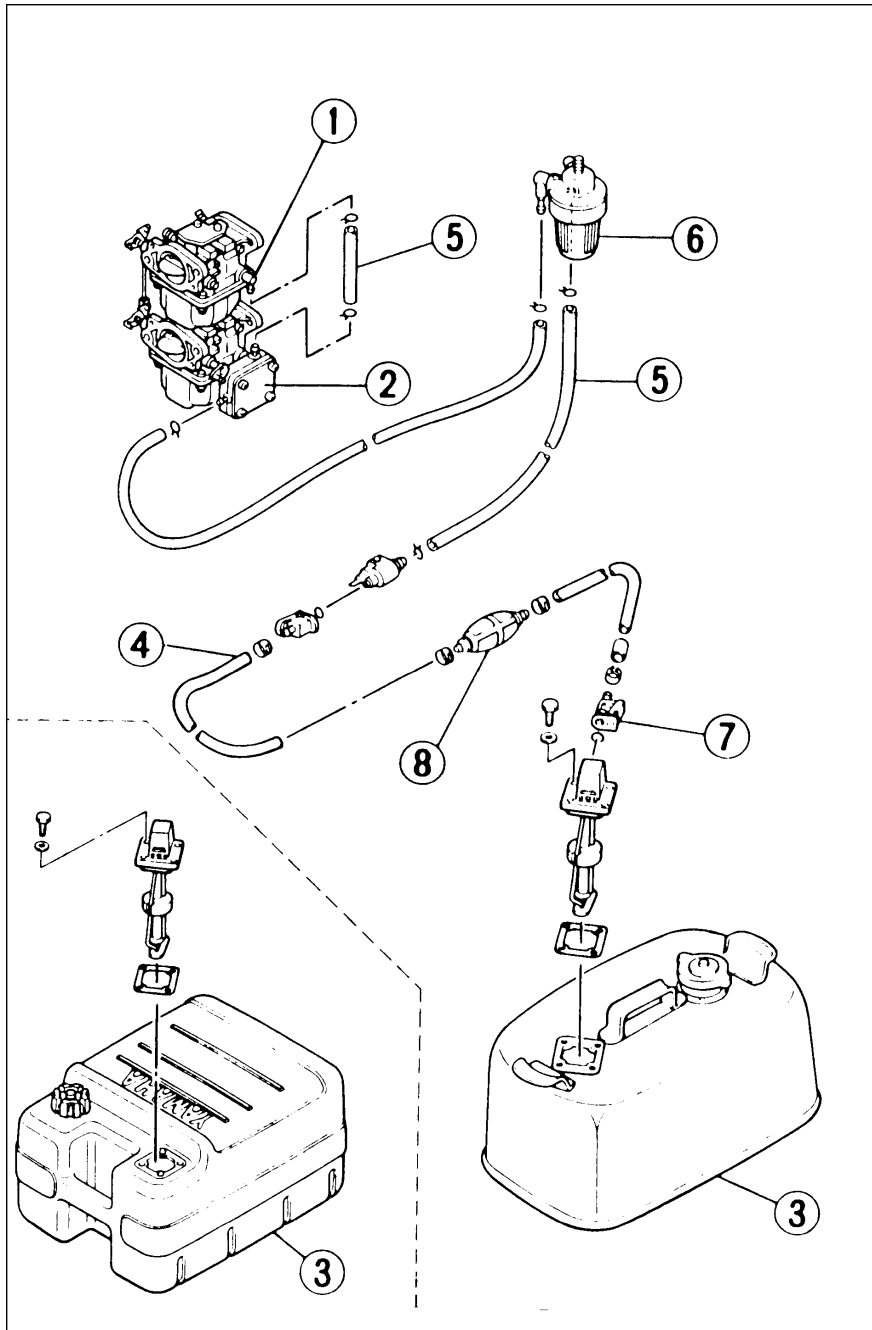
SECTION 3

OUTBOARD MOTOR MAINTENANCE



FUEL SYSTEM

The fuel system should be regularly inspected for leaks, cracks or malfunction.



FUEL SYSTEM INSPECTION

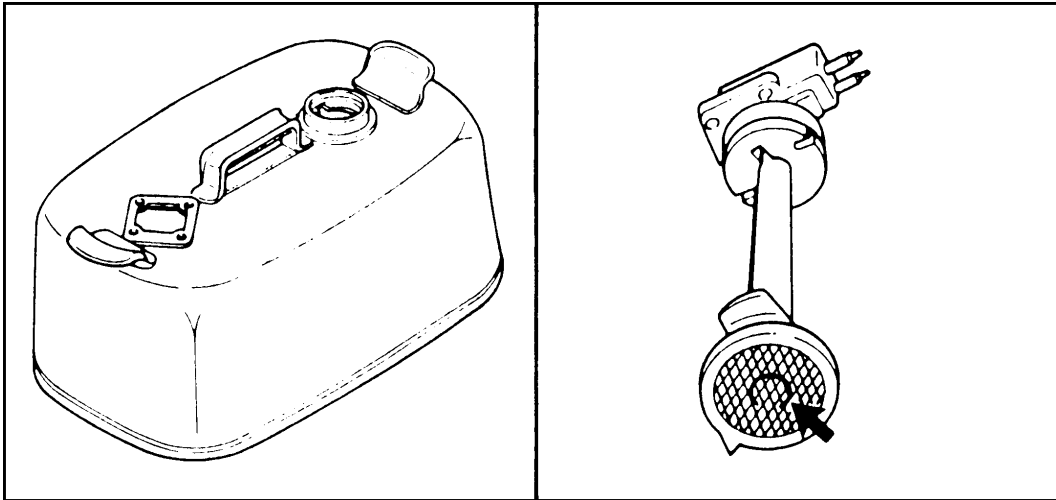
- | | |
|-------------------------------------|-------------------------------------|
| 1. Carburetor leakage | 5. Fuel hose cracks or other damage |
| 2. Fuel pump malfunction or leakage | 6. Fuel filter leakage |
| 3. Fuel tank leakage | 7. Fuel connector leakage |
| 4. Fuel hose joint leakage | 8. Primer bulb leakage or damage |



Cleaning the portable fuel tank and its filter

At least **once every six months**, empty the fuel tank, pour a small quantity of detergent, and clean the tank thoroughly by shaking it. Flush the inside with fresh water and drain it completely. Repeat the flushing and draining procedures several times until all the detergent has been removed from inside the tank.

Thoroughly clean the tank filter (located at the end of the suction pipe) with detergent and air dry.

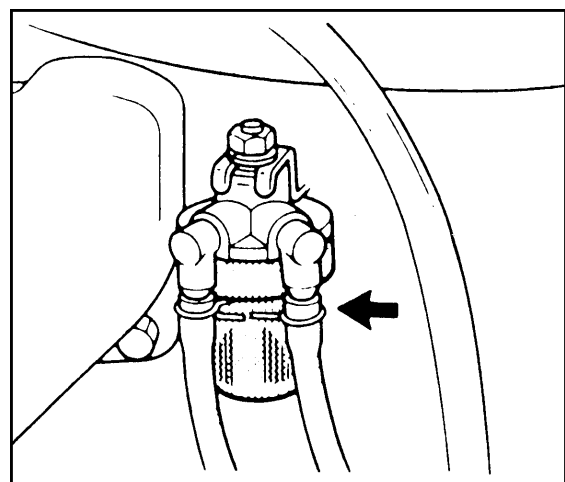


FUEL TANK AND TANK FILTER CLEANING

Cleaning the engine fuel filter

The engine fuel filter should be cleaned every 20 hours of operation or **every month**. In some countries, the fuel quality is poor so cleaning of the filter should be carried out more frequently.

Stop the engine before removing the filter. Keep away from sparks, cigarettes, flames or other sources of ignition. Remove the fuel hoses and clean the filter with detergent. Air dry the filter then put it back in place making sure the filter case is tightly screwed.



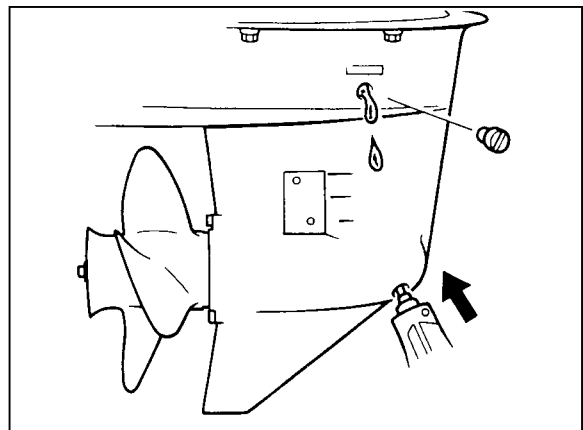
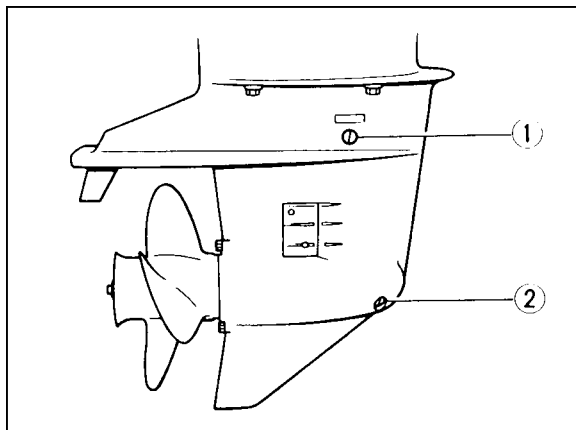
FUEL FILTER CLEANING



GEAR-BOX OIL CHANGE

Gear-box oil should be changed every 100 hours of operation or **six monthly**, whatever comes first.

Drain the gear-box into a container by opening the oil-drain plug (2) then the oil-level plug (1). With the outboard motor in the upright position, inject the recommended gear-box oil into the oil-drain plug hole (2) until it starts to flow out of the oil-level plug hole (1). Insert and tighten both the drain plugs.

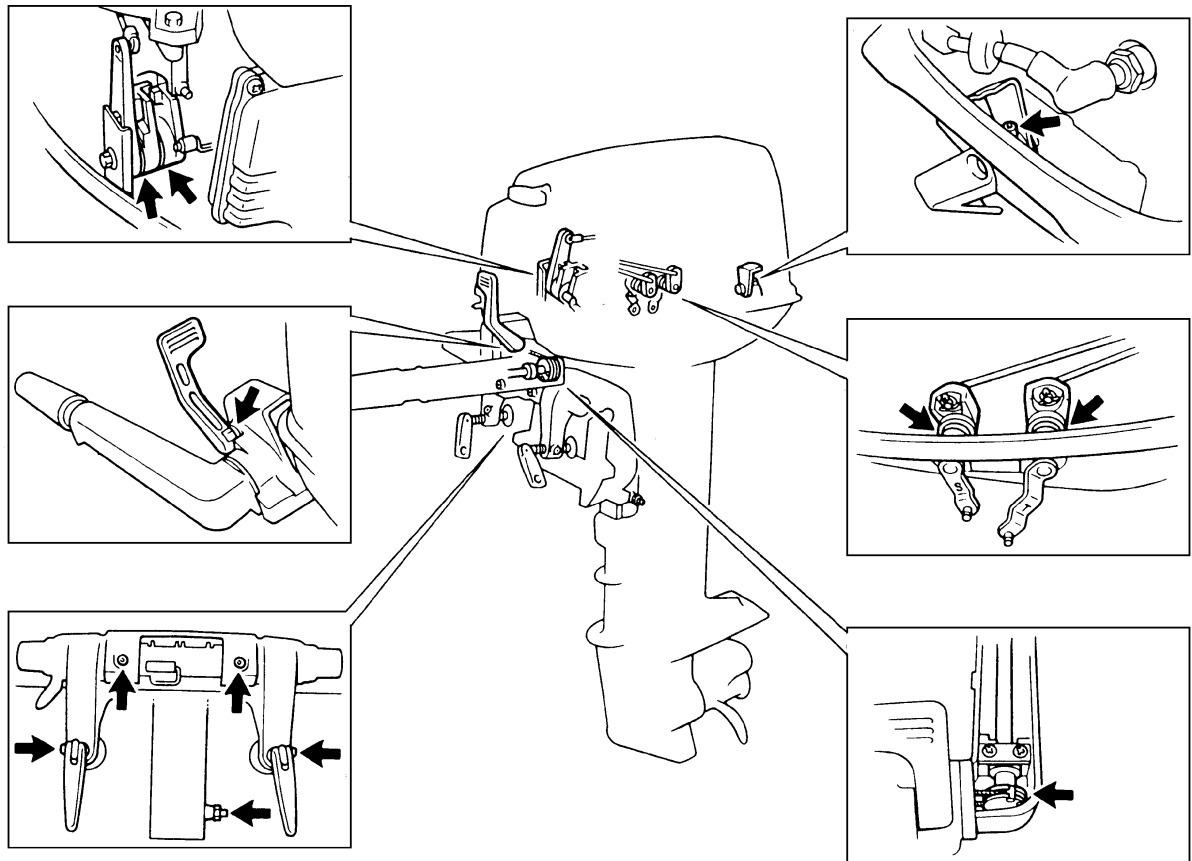


CHANGING THE GEAR-BOX OIL



EXTERNAL LUBRICATION

Every three months, a recommended (marine) grease should be injected through the specified points (grease nipples) on the outboard motor. This procedure will ensure all moving parts operate smoothly.



YAMAHA GREASE POINTS



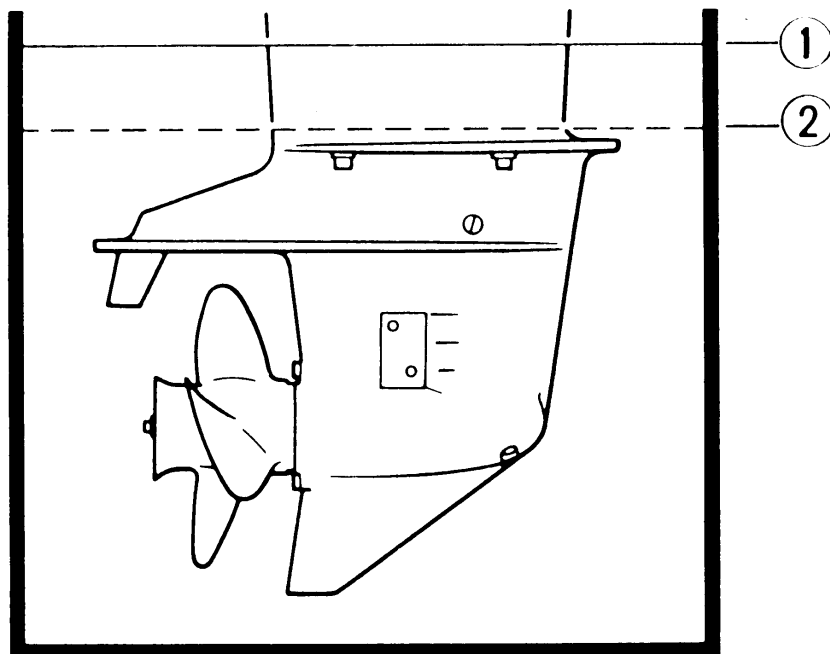
COOLING SYSTEM

The outboard motor cooling system is the part of the engine most likely to cause problems due to salt, sand and dirt entering the system. Water pumps should be inspected and the pump impeller changed every 200 hours of operation or **once a year**, whatever comes first.

It is important to keep an eye on the tell tale water stream as a drop in flow is likely to indicate a problem with the cooling system. It could be a blockage around water intakes (plastic bags in the water are a common cause), sand in the system, water pump failure, damaged pump impeller and so on. It may also simply be a blockage of the outflow (sand) from the tell tale although the engine cooling system is operating correctly.

Flushing the cooling system with fresh water

You can help prevent some of the problems caused by salt buildup in and around the motor by washing the body and flushing the cooling system with fresh water after use. To clean the cooling water passages, mount the motor in a tank partly filled with fresh water (water level above the anti-cavitation plate). Put the motor into neutral, start and run at low speed for a few minutes. This procedure should be carried out at least **once every month**. If possible, run the engine in fresh water on completion of each trip.



THE COOLING SYSTEM

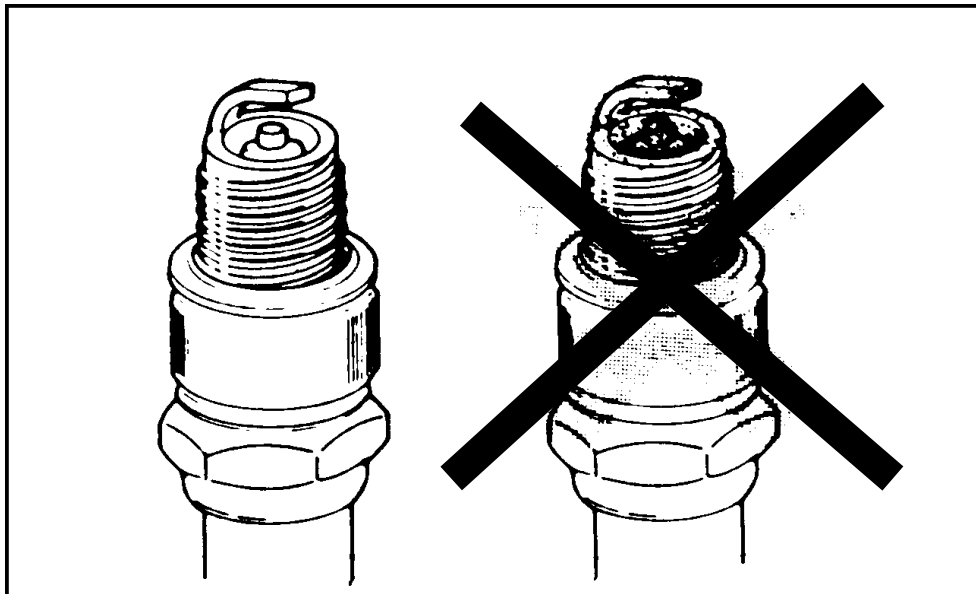
1. Water surface
2. Lowest water level



SPARK PLUGS

Cleaning or replacing spark plugs

The spark plugs of an outboard motor can become oily and coated in a black deposit in a short time. When this happens the motor will run roughly or may even fail to start. Spark plugs should therefore be removed and inspected after 20 hours of operation or **once a month**. If spark plugs are dirty they should be cleaned or replaced with new ones as recommended for that type of motor.



SPARK PLUG CONDITION

Checking for spark

If an outboard turns over but does not start, the spark plug should be checked for spark to find the problem. To do this, you should first make sure that there is good ventilation and no fuel vapour present. Remove the spark plug from the engine and reconnect it to its lead. Hold its body against the engine block (to earth it) and turn the engine over. Spark should be seen across the gap. Keep the spark plug away from the plug hole to safeguard against the risk of ignition.

If spark present: Plugs are dry - check fuel supply, lines, filters

Plugs are dirty - clean or replace plugs

Plugs are wet - engine flooded, let stand for a while and try again

If no spark: Loose or wet wiring. Check all wiring connections for tightness, should be clean and dry. Spray dirty, wet wiring with water-repellent spray. If engine still does not start, seek mechanical advice.

Take care when replacing spark plugs not to over tighten as this may damage the plug or make it difficult to unscrew.



FUSES

Fuses protect electrical wiring and equipment from damage or fire due to electrical overloads. A fuse is designed to melt when overheated due to excessive current flowing through an electrical circuit. The circuit becomes open, no more current flows through it and therefore the electrical equipment is protected.

If a fuse does “blow”, it should be replaced with one that is recommended for that purpose. Some spare fuses should be carried on board in case this happens. If a fuse repeatedly “blows”, it indicates a serious problem which should be looked at by a qualified person to find the cause.

BATTERIES

Batteries should be inspected regularly to make sure they are secured in place to stop movement as a vessel rolls. They should also be kept topped up with distilled water to just above the plates. Batteries must be kept dry and clean, and the connections tight. The terminal posts should be coated in Vaseline to prevent them from corroding.

Batteries contain hydrogen gas, which is highly explosive so must be kept clear of sparks, heat, flames, lit cigarettes and so on. They also contain acid, which burns the skin so must be handled carefully.

PROPELLERS

Propellers are easily damaged by hazards in the water, hitting the bottom and corrosion. Even slight damage can cause a reduction in speed. Propellers on outboard motors are fitted with a shear pin, which is designed to break, if the propeller hits a solid object. The pin is easily replaced.

If a propeller blade is bent or badly chipped, it is best to fit a new propeller as it will not work very well. Make sure you only fit a propeller, which is recommended by the outboard manufacturer.

Every three months, the propeller should be pulled off and the propeller shaft greased.

ZINC ANODES

A zinc anode is fitted near the propeller to prevent corrosion and should be replaced when almost worn away. The zinc anode should be pulled off and scrubbed once **every three months**.



PERIODIC INSPECTION AND SERVICE

The following table is given as a guideline for periodic maintenance procedures. These inspections and services are recommended for outboard motors used on an average of 20 hours per month. Depending on operating conditions, the intervals between maintenance procedures may need to be changed.

SERVICES \ INTERVALS	1 MONTH	3 MONTHS	6 MONTHS	1 YEAR	2 YEARS
RUN ENGINE IN FRESH WATER	X				
FUEL FILTER: CHECK & CLEAN	X				
SPARK PLUGS: CHECK CONDITION & CHANGE IF NECESSARY	X				
PROPELLER: PULL OFF & CLEAN PROPELLER SHAFT		X			
ZINC ANODE: PULL OFF & SCRUBB		X			
ENGINE HEAD: FLUSH w/ FRESH WATER, CLEAN, SPRAY CRC, GREASE		X			
ENGINE LUBRICATION: GREASE THE SPECIFIED POINTS		X			
FUEL TANK: CLEAN w/ DETERGENT & FRESH WATER			X		
CRANKCASE: DRAIN & REFILL w/ OIL			X		
IMPELLER: REPLACE IMPELLER & GREASE CRANKSHAFT				X	
FULL SERVICE BY AUTHORISED DEALER					X

